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The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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Sintering Grate and Rotary Kiln Gain Fuel Economy

Heat Balance of Lepol Kiln—Thermal and Mechanical Principles Are Sound—No Radical Change in Methods—Twelve Installations in European Plants

By T. H. ARNOLD
Consulting Engineer, Plainfield, N. J.

In this second article of a series of three, Mr. Arnold discusses the development of the burning process that combines the use of a sintering grate and a rotary kiln, and he presents detailed data on the utilization of heat by several of the more recent commercial installations.

In the next article the author will consider the economic aspects of the Lepol process.—The Editors.

(Continued from April Issue)

THE sub-heading, "Some Trouble With Alkali Salts," in the second column on page 56 of the April installment of these articles, is subject to a wrong interpretation, inasmuch as no trouble of this character occurs with the Lepol system. It does often occur where other means of dust collection are used.

A New Method of Dust Precipitation

The Lepol system, in fact, introduces a new method of dust precipitation which eliminates many of the troubles encountered by the methods previously used. Occasionally, with the older methods of dust precipitation, the contamination from the alkali salts was so great that the dust recovered was rendered unsuitable for remixing with the raw feed when returned to the kilns. A vast difference in the material recovered is noticeable, due to the difference in the method of precipitation. Practically all other methods of dust precipitation require that the gas travel be slowed down to allow an effective separation of the dust particles from the gases. The alkali fumes which are condensed as particles of molecular volume will agglomerate with other particles of alkali fume or with dust particles until they become of sufficient size to drop out of the gas stream. This, however, takes a very appreciable time and the last treater sections always carry appreciably higher percentages of alkali salts in the dust.

The Lepol system operates upon an entirely different principle and the dust collection may be varied over quite a wide range by changing the thickness of the bed of material on the grate, by changing the speed of the grate, by changing the size of the nodules, or by changing the draft. The gas temperature above the bed of the materials is sufficient to insure the volatilization of the alkali salts. The temperature drop through the bed of the materials is quite rapid and the gases leaving the grate are well below the temperature at which these salts condense. The depth of the bed of material is only a few inches and the velocity of the gases through the bed is increased considerably above the normal rate of travel. The time necessary for this travel is extremely small. Thus the time during which the gases are in contact with the raw material is entirely too short for these particles to agglomerate sufficiently to be precipitated. After leaving the grate the gases pass immediately out of the stack. Thus there is no possibility of the alkali salts contaminating the raw materials. In this way one trouble which has proved rather bothersome with other types of dust collection may be entirely eliminated through the application of the Lepol system.

New Process Based on Correct Principles

The relative advantages of the shaft kiln and the rotary kiln have been thrashed out long ago. Always in the background the high thermal efficiency of the shaft kiln, with its consequent saving in fuel, has been held up as a reproach to the advocates of the rotary kiln. Much ingenuity has been exercised in the various attempts to bring about in the rotary kiln the intimate admixture of the material and gases which is necessary for the proper heat transfer in the lower temperature zones.

The sintering grate was not altogether new and presented no marked difficulties in its application to this process. Early attempts to complete the process on the grate were found to be impractical. However, the combination grate as a preliminary step and the finishing of the partially processed material in the rotary kiln appeared logical and practical.

Any process, to be sound in practice, must involve a firm basis in fundamental principles, which if carefully and thoroughly studied will reveal the commercial possibilities and justification for its introduction into the industry. That the Lepol system has such a basis upon correctly applied fundamental thermal principles has been checked quite carefully on numerous occasions.

Experiments Made on Commercial Scale

Before any commercial applications were attempted, when the process was little more than a theory, a commercial scale test was arranged at the plant of the

Deutsche Portland Zement "Adler" A. G., at Ruedersdorf, near Berlin, Germany. After preliminary experiments a thorough test was conducted by the Kiln Commission of Association of German Portland Cement Manufacturers.

A small kiln of an obsolete type was equipped with the necessary apparatus and operated by this process. The following data were obtained on this test:

Dimensions of kiln, 7 ft. diam., 80 ft. long.
Dimensions of cooler, 4 ft. diam., 36 ft. long.
Output of kiln per day (24 hrs.), 540 bbl.
Average $CaCO_3$ in raw material, 77.5 per cent.
Consumption of coal dust per day (24 hrs.) with heating value of 11,495 B.t.u. per lb., 32,467 lb.
Coal dust in percentage of clinker, by weight, 15.9 per cent.
Pounds of 13,500-B.t.u. coal per bbl. of clinker (380 lb.), 51.2 lb./bbl.
Moisture in nodulized raw material, 13.8 per cent.
Water to be evaporated, per bbl. clinker, 93.6 lb.
Temperature of kiln gases at exhaust fan, 228 deg. F.
Volume of gases per bbl. of clinker, 16,300 cu. ft.
Temperature of clinker leaving cooler, 627 deg. F.

The heat balance given for this test was on the basis of the heat for 1 bbl. of clinker, as follows:

	B.t.u.
Heat input, per bbl.	691,540
Heat consumption—	
Theoretical heat consumed in burning 1 bbl. of clinker	286,000
Evaporation of water, 93.6 lb. of water per bbl.	103,470
Sensible heat in exit gases, 16,300 normal cu. ft. of gases at 228 deg. F.	67,550
Heat in clinker leaving cooler	47,420
Radiation, conduction, and other losses	187,100
Total heat per bbl. of clinker	691,540

The cooler was evidently not correctly proportioned for the amount of clinker it was forced to handle, inasmuch as the normal output of the kiln previously was 300 bbl. per day, and this was raised to 550 bbl. per day. Thus the temperature of the discharged clinker was far too high. While the lack of proper proportions and heat insulation resulted in high losses, the results attained are remarkable in that they closely approach the heat economy of the shaft kiln.

On the basis of the fuel economy shown in this test kiln, a number of European cement manufacturers have installed kilns of this type. Thus in addition to the test plant at Ruedersdorf, there is one kiln for burning cement from calcium sulphate and eleven kilns for burning portland cement, two of which will burn special high-strength cement corresponding to our high-early-strength cements.

The geographical distribution and general characteristics of the commercial kilns of this type now in use are shown in Table 2.

Naturally as the basic principles and relationships of a new process are better understood some improvements are to be expected. However, the losses have here been reduced to a figure which does not permit any radical reduction. The following data illustrate the commercial results attained in one of the more recent installations:

Dimensions of kiln, 10 ft. diam., 105 ft. long.
Dimensions of cooler, 7 ft. 5 in. diam., 65 ft. long.
Output of kiln per day (24 hrs.), 1,192 bbl.
Average $CaCO_3$ content of raw material, 77 per cent.
Oil consumption per day (24 hrs.) with heating value of 17,850 B.t.u. per lb., 39,380 lb.
Oil consumption in percentage of clinker, by weight, 8.73 per cent.
Heat consumed per bbl. of clinker, 590,635 B.t.u.
Moisture in nodulized raw material, 13 per cent.
Water to be evaporated, per bbl. of clinker, 89.3 lb.
Temperature of kiln gases at exhaust fan, 212 deg. F.
Volume of gases per bbl. of clinker, 17,100 cu. ft.
Temperature of clinker leaving cooler, 482 deg. F.

The heat balance given for this test was given on the basis of the heat for 1 bbl. of clinker, as follows:

	B.t.u.
Heat input	590,635
Heat consumption—	
Theoretical heat consumed in burning 1 bbl. of clinker	286,000
Evaporation of water, 89.3 lb. of water per bbl.	98,865
Sensible heat in exit gases, 17,100 cu. ft. of gases at 212 deg. F.	65,160
Heat in clinker leaving cooler	34,800
Radiation, conduction, and other losses	105,810
Total heat per bbl. of clinker	590,635

TABLE 2

Operating Results at Lepol Kiln Installations

					Guaranteed		Actual operation		
Locatiton	Product	Kiln dimensions diam. length	Fuel	Date in operation	Output, bbl. per day	Heat consumption B.t.u. per bbl.	Output, bbl. per day	Heat consumed, B.t.u. per bbl.	Equivalent lb. of 12,500-B.t.u. coal per bbl.
Germany	Portland cement*	8'-2"x106'	......	......	......	......	464	......	......
Switzerland	High strength cement	9'-3"x 92'	Coal	7/1/30	988	682,400	1,133	668,700/716,500	53.5/57.3
Germany	Portland cement	10'-0"x 92'	Coal	1/18/30	1,162	682,400	1,261	647,400	51.8
Spain	Portland cement	10'-7"x112'	Coal	3/9/31	1,395	682,400	1,412	682,400	54.6
Dalmatia	Portland cement	10'-7"x112'	Coal	4/25/31	1,452	682,400	1,628	600,500	48.0
Roumania	Portland cement	10'-7"x105'	Oil	6/25/31	1,162	716,500	1,192	590,900	47.3
Luxembourg	Slag portland cement	10'-7"x112'	Coal	7/28/31	1,452	682,400	1,599	601,700	48.2
Morocco	Portland cement	9'-0"x112'	Coal	8/10/31	1,162	682,400	......	......	......
Spain	Portland cement	10'-0"x105'	Coal	10/21/31	1,162	682,400	1,382	585,200	46.8
Spain	Portland cement	9'-3"x 92'	Coal	......	872	682,400	......	......	......
Italy	Portland cement	9'-0"x 99'	Coal	......	1,162	682,400	......	......	......
Switzerland	High strength cement	......	Coal	......	1,162	682,400	......	......	......

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*Portland cement and sulphuric acid from sulphate materials.

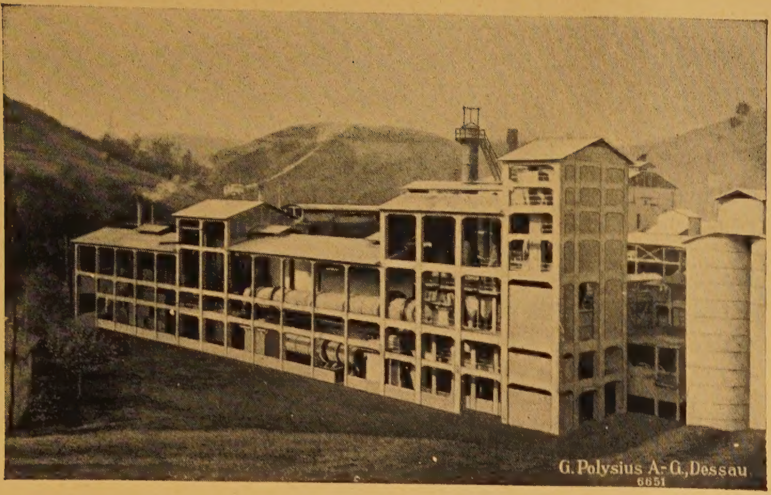

***Figure 6 (Left)*—Kiln building for the Lepol kiln at the plant of Cementos Rezola S.A. at San Sebastian, Spain. Note the comparatively short length of building for the kiln and cooler**

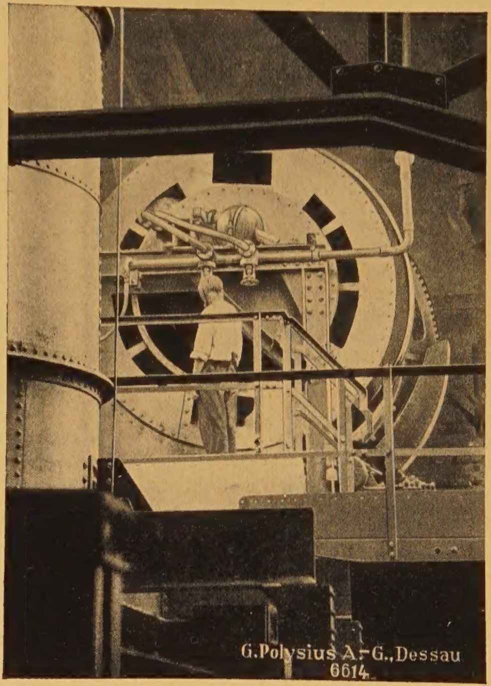

***Figure 8 (Above)*—Nodulizing drum or Hydroballer preparing the raw material at Kronstadter Portlandzementfabrik, Kugler & Cie., Aktiengesellshaft, Kronstadt-Brasov, Roumania**

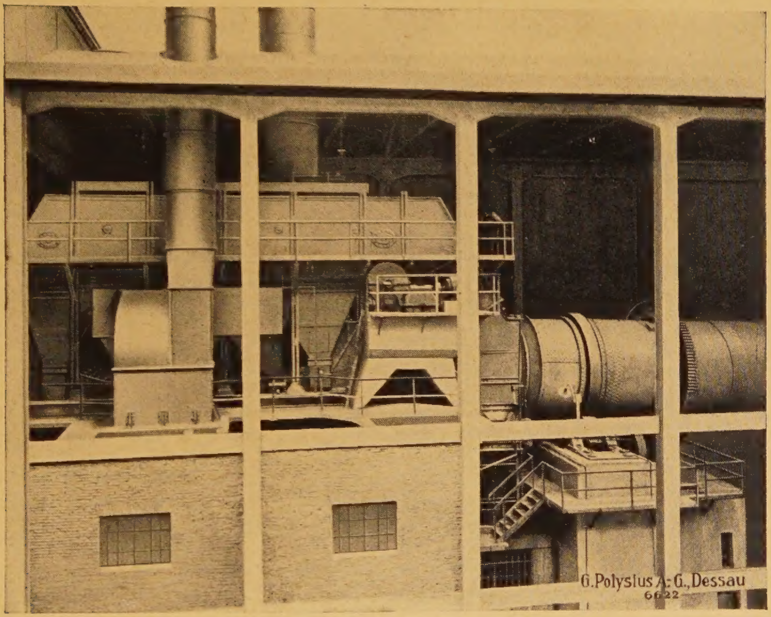

***Figure 7 (Left)*—Feed end of kiln and grate housing for Lepol kiln at Societa anonima commercio Cementi Portland "Dalmatia," Kastel Sucurac, near Spalato. The compact yet accessible arrangement of the equipment is quite evident**

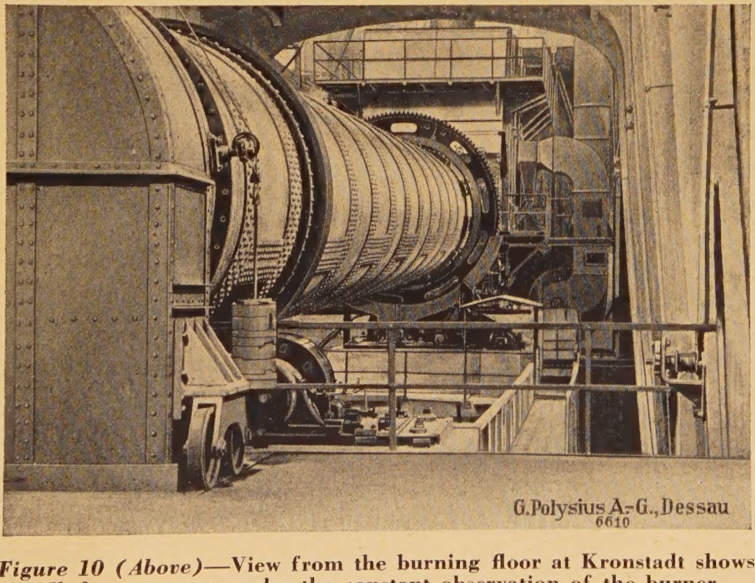

***Figure 10 (Above)*—View from the burning floor at Kronstadt shows all the apparatus under the constant observation of the burner**

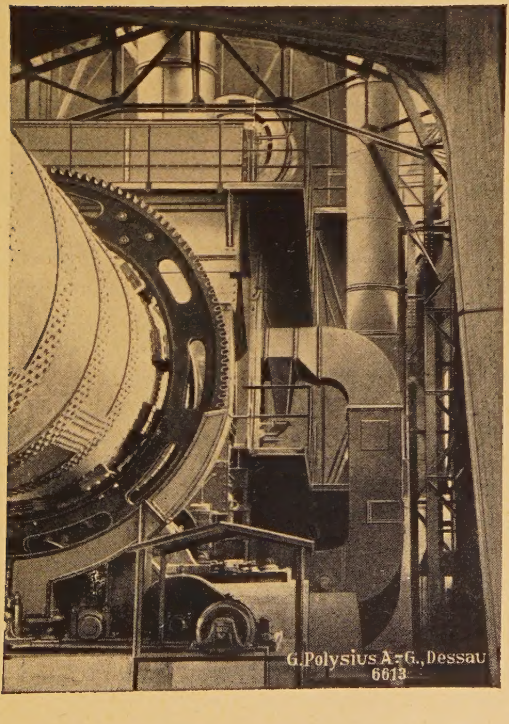

***Figure 9 (Left)*—Feed end of the Lepol kiln showing the exhaust fan below the kiln and the nodulizing drum above the grate housing at Kronstadt. Compact yet accessible**

A comparison of the heat balance in this plant with that of the Ruedersdorf experimental kiln is given in Table 3 and is quite interesting in showing how some of these losses have been reduced in the more recent installations. It would not appear that any of the items in Table 3 may be reduced materially, although improvement in insulation may bring down the last item to some extent.

TABLE 3

Comparison Between Experimental Plant and More Recent Installation

	Ruedersdorf, 550 bbl. per day		More recent installation, 1,192 bbl. per day	
	B.t.u.	per cent	B.t.u.	per cent
Theoretical heat for burning	286,000	41.4	286,000	48.6
Evaporation of water	103,470	14.9	98,865	16.7
Sensible heat in exit gases	67,550	9.75	65,160	11.0
Heat in clinker leaving cooler	47,420	6.85	34,800	5.9
Radiation, conduction and miscellaneous	187,100	27.1	105,810	17.8
	691,540	100	590,635	100

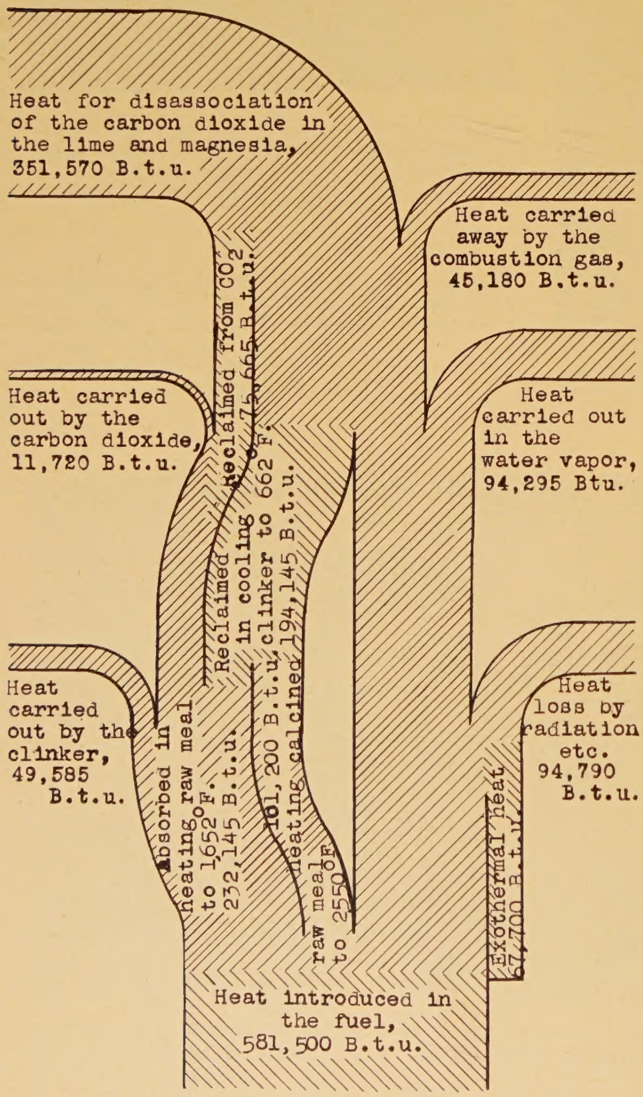
Heat for disassociation of the carbon dioxide in the lime and magnesia, 351,570 B.t.u.
Heat carried away by the combustion gas, 45,180 B.t.u.
Heat carried out by the carbon dioxide, 11,720 B.t.u.
Heat carried out in the water vapor, 94,295 Btu.
Heat carried out by the clinker, 49,585 B.t.u.
Heat loss by radiation etc. 94,790 B.t.u.
Reclaimed from CO2 75,665 B.t.u.
Reclaimed in cooling clinker to 662 °F. 194,145 B.t.u.
Absorbed in heating raw meal to 1652 °F. 232,145 B.t.u.
101,200 B.t.u. heating calcined raw meal to 2550 °F
Exothermal heat 67,700 B.t.u.
Heat introduced in the fuel, 581,500 B.t.u.

Figure 4. Chart showing heat flow diagram for the combination of the sintering grate and the rotary kiln

No Radical Change in Method

On the whole, the process as now developed appears to be quite efficient in the use of fuel. It does not introduce any radical new methods of operation. The equipment can readily be handled by the type of men now utilized in this class of work. The burning process is maintained as a separate department which may be operated to burn the greatest amount of clinker at the lowest possible cost. Special high-strength cements and high-early-strength cements are now being made on this equipment at far less cost than they have been produced in America. The cost of the equipment is sufficiently low so that a large part of the difference between the present fuel cost and that possible with this type of equipment may be realized as a cash saving.

Utilization of Heat in Commercial Installation

The transfer and utilization of the heat in the various intermediate processes throughout the combination of the sintering grate and the rotary kiln are shown graphically in Figure 4, which is the heat flow diagram for another commercial plant operating on this system.

The following data are given for this plant:

Output per kiln per day		1,380 bbl.
Heating value of coal		12,850 B.t.u. per lb.
Pounds of coal per barrel		45.2
Heat required per barrel		581,500 B.t.u.
Water added to nodulize		12 per cent
Theoretical heat for expelling carbon dioxide		351,570 B.t.u. per bbl.
Heat carried out by gases at 300 deg. F.—		
Total heat in water vapor	94,295	
Heat in combustion gases	45,180	
Heat in carbon dioxide	11,720	
		151,195 B.t.u. per bbl.
Heat carried out by the clinker at 662 deg. F.		49,585 B.t.u. per bbl.
Heat returned in cooling clinker (2,550 to 662 deg. F.)		194,145 B.t.u. per bbl.
Heat returned from carbon dioxide gas		75,665 B.t.u. per bbl.
Heating raw materials to calcining temperature (1,652 deg. F.)		232,145 B.t.u. per bbl.
Heating raw materials to clinkering temperature (2,550 deg. F.)		101,200 B.t.u. per bbl.
Exothermal heat in clinkering reaction		67,740 B.t.u. per bbl.
Radiation from kiln, cooler, grate, and other loss		94,790 B.t.u. per bbl.

The great importance in returning the recuperated heat to the kiln is clearly shown by this chart. The intimate contact of the gases and the materials on the grate enables the utilization of the low temperature heat in the gases for heating, drying and calcination.

A careful study of both the charts (in Figures 4 and 5) is justified, as these show clearly, in a graphical manner, how the recuperation effects the saving of heat in this process. The heat recovered in one portion of the process is re-used later to replace heat of a higher temperature potential, and thus of greater cost. Figure 4 visualizes the logical thermal basis of the process through the return and re-use of the heat. Beginning at the bottom of the chart, 581,500 B.t.u. are introduced by the combustion of the fuel necessary for the burning of a barrel of clinker. The exothermal heat of the chemical reaction in forming the silicates adds 67,740 B.t.u. of this total, 232,145 B.t.u. are consumed in heating the materials to the calcining temperature of 1,652 deg. F., and a further amount of 101,200 B.t.u. is required to heat the calcined materials to the temperature of the reaction, 2,550 deg. F. Of this heat, 49,585 B.t.u. is wasted in the clinker, which is discharged from the cooler at 662 deg. F., and 11,720 B.t.u.

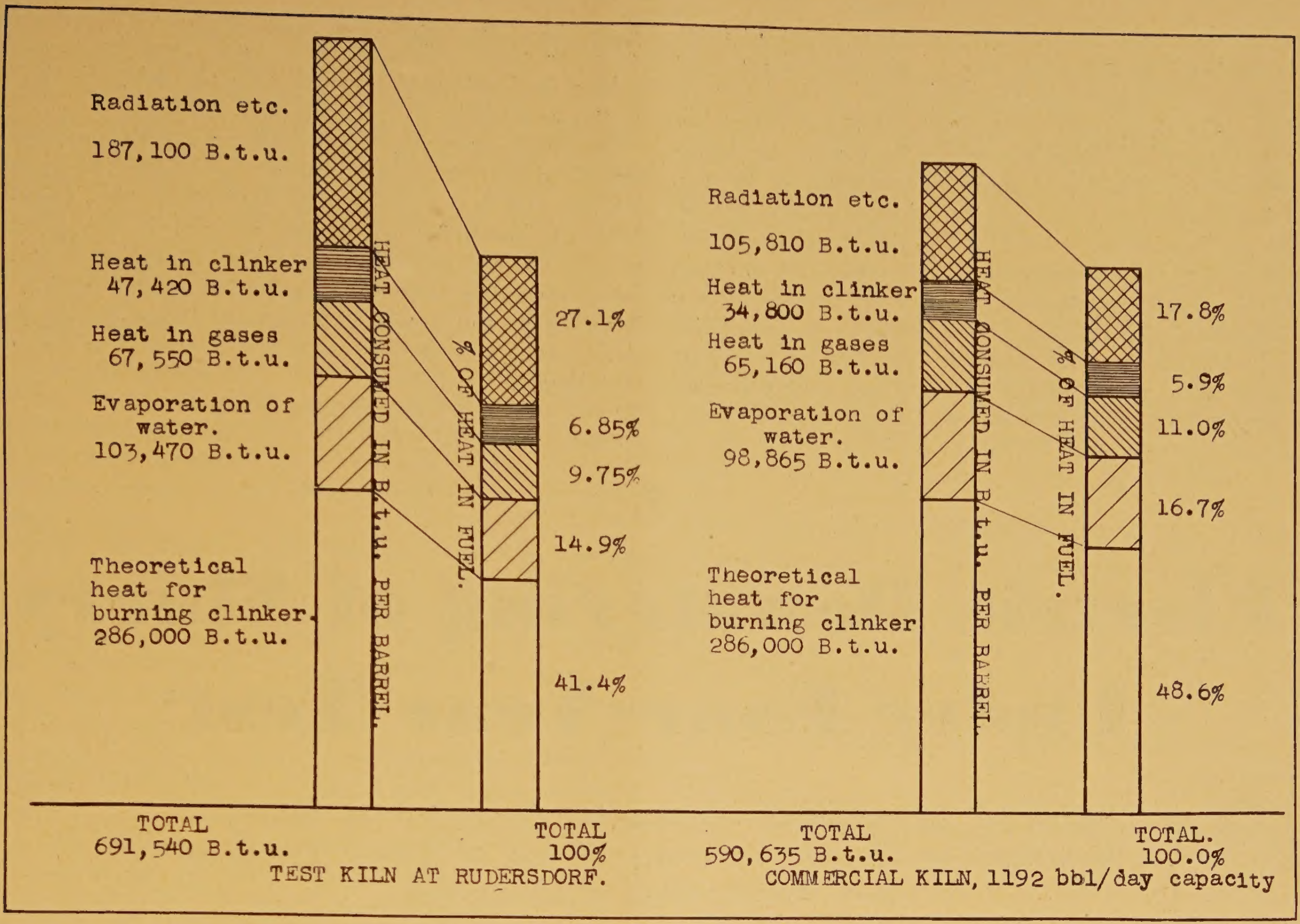

Figure 5. Chart showing the comparison of the heat distribution in developing the commercial kiln

are wasted in the carbon dioxide gas from the limestone. As the total radiation is obtained later, we can assume that the remaining heat is recovered and returned to the system.

The heat transferred to the secondary air for combustion in cooling the clinker will amount to 194,145 B.t.u., while 75,665 B.t.u. is reclaimed from the carbon dioxide from the mix as it passes through the material on the grate. The dissociation of the carbon dioxide from the calcium carbonate in the mix will absorb 351,570 B.t.u., or 60 per cent of the heat in the fuel. The combustion gases will carry out 45,180 B.t.u., and the evaporation and superheating of the water in the mix will absorb 94,295 B.t.u. There will remain 94,790 B.t.u. to be accounted for in radiation, from the kiln, cooler, grate housing, and connecting chute, in the loss from air infiltration, or in other losses.

Aiding the Cooling of Clinker

The discharge of the clinker at a temperature of 662 deg. F. may elicit considerable criticism in certain quarters. However, the actual heat loss is not great. It is 49,585 B.t.u. per barrel, or 8.5 per cent of the total heat in the fuel. Proper cooling of the clinker was one of the great difficulties encountered in the perfection of the process. The solution of this problem required considerable alterations in the air distribution at the burning end of the kiln. As the amount of fuel per barrel is reduced, the weight of air required for the combustion is correspondingly reduced. With such extremely low fuel consumption, we reach a point where the amount of the secondary air passing through the rotary cooler will not be sufficient to absorb the heat given off in cooling the clinker down to temperatures suitable for grinding.

In order to take the fullest advantage of the conditions the burning apparatus has been devised to fit the requirements of the process. A special high pressure type of burner has been developed which feeds the coal with a minimum of primary air, thus allowing a maximum of secondary air through the cooler. In order to increase the heat transfer and utilize this limited amount of air to the utmost, a cellular type of cooler has been adopted. Further refinements of the process will probably reduce these losses somewhat, although the total losses in the recent installations leave comparatively little upon which to base hopes for any considerable reduction in the future. Some minor savings may be effected through passing additional air through the cooler to absorb the heat to cool the clinker down to a lower temperature. The surplus hot air may be used in drying the coal or perhaps in the drying compartment of the grate to dry the nodules before calcining. The practical working out of these details would not involve any great difficulties and thus may be included in some of the future designs.

Sound Thermal and Mechanical Principles

The process is thus based upon sound thermal and mechanical principles which may readily be understood and verified by any combustion engineer. In the utilization of the heat, full advantage is taken of the application of the heat at the proper temperature gradient at which the greatest efficiency in utilization may be attained. While some additional economies may be introduced in the future refinement of the process, these must be minor in nature, for there remains but little opportunity for greatly decreasing these losses. Thus no marked improvement in thermal savings may be expected over this process as now offered. The mechanical construction of the apparatus is such that it is simple and substantial and with reasonable attention should operate continuously over long periods with a minimum of repairs. The process involves no radical departure from accepted methods, requires no specially skilled labor, and presents no difficult operating problems.

In presenting this process with its reduction in manufacturing costs at this time, when the industry is in need of some tonic influences, those who have been instrumental in developing it feel that they will benefit the industry as a whole.

Although there may occur instances where the process described may not be applicable for economic or process reasons, the various savings in production costs, coupled with the additional advantages inherent in the process should warrant careful investigation on the part of all plant executives who are conscientiously endeavoring to meet the present trends of the cement industry. The economic aspects of the process will be discussed in the next installment.

(To be concluded)

◆

Electric Dewatering of Slurry Under Four-Year Test[1]

Scope of Investigation—Measuring Viscosity of Slurry—Reactions to Electric Current—Effects of Time, Temperature, and Spacing of Electrodes

By HEWITT WILSON[2] and H. G. WILCOX[3]

This is the second installment of an article, written at the request of "Concrete," describing the results attained in dewatering cement slurry by electricity during a four-year test conducted at the Northwest Experiment Station of the U. S. Bureau of Mines. —The Editors.

THE article in last month's issue discussed the principles involved in the dewatering of cement slurry by electricity. References were given to previous investigations, and the requirements of a machine for dewatering cement slurry were outlined. The present article covers the scope of the investigation at Seattle and the test methods employed.

Scope of Investigation

This investigation was conducted to determine the following points: (1) the possibility of dewatering cement slurry on the rotary-anode-type electrophoresis machine used for dewatering kaolin at the Northwest Experiment Station; (2) the best electrolyte and the optimum percentage needed; (3) the proper spacing of anode and cathode; (4) the most suitable electric current; (5) the cost of dewatering; (6) verification of the effect of increased cathode area as reported by Curtis.[12a] This report by no means completes the study of the above factors.

Description of Materials Used

The slurry was furnished by the Pacific Coast Cement Co. and was composed of about 22 per cent glacial clay and 78 per cent limestone. The limestone was shipped by boat from Dall Island, Alaska. The glacial clay was mined near the plant of the Pacific Coast Cement Co. in Seattle, and dispersed in a drag-type blunger to produce a slip containing about 35 per cent solids. The clay slip and crushed limestone were then ground together in ball mills. The resulting slurry contained about 62 per cent of solids, 90 per cent of which passed a 200-mesh screen, and contained 43 per cent to 44 per cent of lime. Cottrell precipitator dust was not returned to the slurry when these tests were started but was returned to the clay blunger before the study was completed. This changed the reaction of the slurry to deflocculating agents.

The reagents used were sodium carbonate, sodium silicate, sodium hydroxide, hydrochloric acid, barium chloride, acetic acid, and nitric acid, but this report is made only on the first two, which were found to be the best for this work.

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[1] Published by permission of the Director, U. S. Bureau of Mines (not subject to copyright).

[2] Engineer (non-metallics), U. S. Bureau of Mines, Northwest Experiment Station, Seattle, Wash.

[3] Research fellow, U. S. Bureau of Mines, Northwest Experiment Station, Seattle, Wash.

[12a] Curtis, C. E., The Electrical Dewatering of Clay Suspensions: *Jour. Am. Ceramic Soc.*, vol. 14, 1931, pp. 219-263.

The analysis of the sodium silicate used was given by the manufacturer as follows: Soda (Na_2O), 6.4 per cent; silica (SiO_2) 24.7 per cent; water, 68.9 per cent; gravity, 34° Bé. A test of the material showed a specific gravity of 1.038 and a solid content of 32.2 per cent. The amounts of sodium silicate used in the following tests indicate dry sodium silicate.

Viscosimeter

A cement slurry must have sufficient fluidity to move freely through the electrophoresis machine. The fluidity or its reciprocal, viscosity, likewise indicates the degree of dispersion produced by admixtures of alkali, and is therefore related to the ease of particle movement by electric power.

Hall[13] describes an apparatus for measuring the viscosity of cement slurry. This type was used after he found the efflux type unsuitable. A weight on a horizontal arm was used to force a paddle on a vertical arm through the slurry. The time of travel through the slurry was used as a measure of the viscosity. A machine similar to Hall's was made, but the difference in time of travel was so small that the changes in viscosity were difficult to measure. The modified machine finally used is shown in Figure 1.

In this machine a measured amount of slurry is put in the pan A. The movable member BG is pivoted at C and is balanced so that the arm G remains against the stop D.

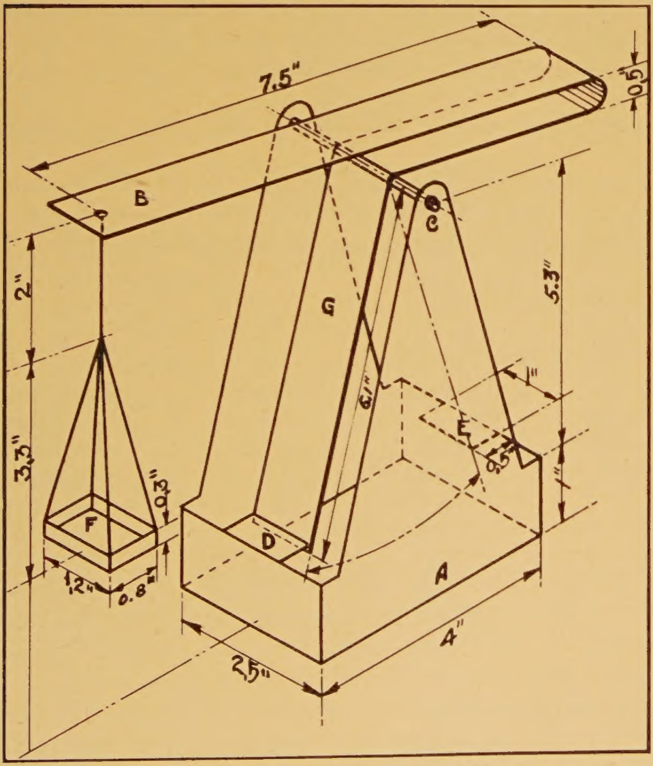

Figure 1. Modified apparatus for measuring viscosity of slurry

Weights are put in the pan F and the arm G is forced through the slurry from D to E. The weight necessary to move the arm from D to E in a given time is used as the measure of viscosity. The time is the constant and the weight the variable, because the weights vary over a much wider range than the time. With this type of machine the viscosity of any fluid can be measured. The relative viscosity given in this work was expressed as the weight in grams needed to force arm G from D to E in three-fifths of a second. Some results were:

	Grams
In air	7.5
In water	8.5
In kaolin suspension (sp. gr. 1.22)	9.3
In glacial clay suspension (sq. gr. 1.32)	14.5
In slurry (depending upon water content)	24.0 to 26.0

The specific viscosity of the untreated slurry calculated from the above figures varied from 2.82 to 3.06.

Preliminary Electrophoresis Tests

Procedure—In order to obtain a view of both anode and cathode during the operation and to conduct the preliminary tests with smaller amounts of slurry, two 4 by 5-in. aluminum plates were joined by insulated connections so that the spacing could be readily changed. These plates, serving as anode and cathode, were placed on end in a gallon stoneware jar containing 2,000 grams of slurry.

Alkalies, when used, were added to the undiluted slurry, the mixture thoroughly stirred and the viscosity measured. All reagents added are given on the basis of the weight of the dry solids in the slurry.

Reaction of untreated slurry to electric current—When the slurry as received from the cement plant was subjected to a direct current of from 2 to 3 amperes with 110 volts, the solids migrated to the anode. The rate of deposition was 22 per cent low in comparison to slurry which had been given the proper electrolyte treatment, and the collected material contained 11.5 per cent more water. The viscosity was too great to permit the material to flow readily through the revolving anode machine.

Reaction of glacial clay to electric current—The glacial clay which was used in the above slurry mixture was made into a slip containing 35 per cent of solids, by weight. On electrophoresis, this gave a fairly thick but wet deposit on the anode. The water content was reduced from 65 per cent to 45 per cent, using 3 amperes with 102 volts.

Reaction of calcium carbonate to electric current. A coarsely ground suspension (35 per cent of solids) of the limestone was not affected by the electric current except to liberate hydrogen bubbles at the cathode. Suspensions containing 35 per cent of precipitated whiting and limestone (ground to pass 325-mesh) gave deposits on the anode. This indicated that calcium carbonate, if sufficiently finely divided, responds to a uni-directional current and carries a negative charge, contrary to Hall's data.

Alkali treatment—Increasing increments of sodium silicate between 0.025 and 0.08 (dry silicate to dry slurry) added to the original slurry increased the viscosity, but sodium carbonate decreased the viscosity when the additions did not exceed 0.3 per cent. Larger amounts tended to raise the viscosity again. The reduction of viscosity was greater for slurry which had been standing for several weeks than for freshly-made slurry. When sodium silicate was added to a slurry containing sodium carbonate, the

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[13] See footnote 11, in April issue.

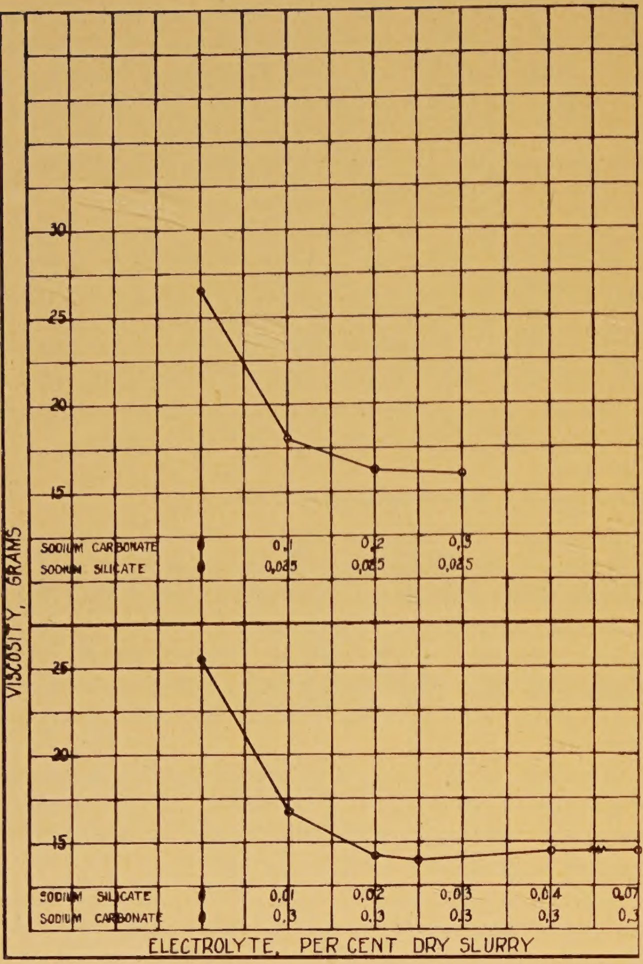

Figure 2. Effect of mixtures of sodium silicate and sodium carbonate on the viscosity of cement slurry

viscosity was reduced further. The mixture that gave the minimum viscosity contained 0.3 per cent of sodium carbonate and 0.025 per cent of sodium silicate. The effect of sodium silicate-sodium carbonate mixtures on viscosity is shown in Figure 2.

The method of adding these two reagents had a pronounced effect on the viscosity. The viscosity was lowered most if the sodium carbonate was added first and the slurry thoroughly stirred before the sodium silicate was added. If the sodium silicate was added first and thoroughly mixed with the slurry, the addition of sodium carbonate would not cause the same decrease in viscosity. The addition of both of the reagents to the slurry at the same time caused a gel to form, which upon stirring would break up into small lumps but would not disperse.

The addition of the optimum percentage of sodium silicate-sodium carbonate mixture to the slurry did not give constant viscosity figures, due to variations in the original viscosity of various batches of slurry, changes in temperature, and varying lengths of time between the additions of the electrolyte and the measurement of the viscosity.

The preliminary electrophoresis treatments of the slurry containing alkali gave variable results. The alkali content selected for further testing in the continuous machine contained 0.3 per cent of sodium carbonate and 0.025 per cent of sodium silicate. This not only gave the lowest viscosity but the greatest rate of water removal and the dryest cake. However, the dry slurry recovered per unit of electrical power was not quite as great as with other alkali concentrations, and considerable variation in alkali concentration can be used without changing the results materially.

Calculation of per cent of water removed—The original slurry contained 62 per cent of solids and 38 per cent of water. If the deposit removed from the drum contains 75 per cent of solids and 25 per cent of water, the weight of water originally held by 75 parts, by weight, of dry slurry then equals $\frac{75 \times 38}{62}$, or 46 parts by weight. Forty-six minus 25 equals 21 parts, by weight, of water removed from 75 parts of slurry—that is, 45.6 per cent of the original water content of 46 parts by weight.

TABLE 1

Effect of Time of Deposition on Anode Deposit

Time, minutes	Average amperes	Average volts	Dry slurry recovered, pounds per hour per sq. ft. anode surface submerged	Solids in anode deposit per cent	Water removed, pounds per kwh.	Dry slurry recovered, pounds per kwh.
0.50	1.8	115	39.0	73.2	6.4	26.4
0.75	1.9	111.5	36.3	74.1	6.3	24.0
1.00	1.9	115.5	34.1	76.0	6.3	21.3
1.25	2.5	113	40.0	74.6	5.3	19.1
1.50	3.0	114	38.5	73.7	4.5	15.2

TABLE 2

Effect of Plate Spacing on Anode Deposit

Spacing, inches	Average amperes	Average volts	Dry slurry recovered, pounds per hour per sq. ft. anode surface submerged	Solids in anode deposit per cent	Water removed, pounds per kwh.	Dry slurry recovered, pounds per kwh.
1.50	3.8	107	51.8	72.7	4.2	17.6
1.75	3.1	107	44.7	74.7	5.0	18.1
2.00	3.1	112	35.8	76.3	4.2	13.9
2.25	2.8	110	31.8	73.6	3.6	14.2
2.50	2.3	110.5	27.9	73.7	3.9	15.2

Other Factors Affecting Electrophoresis

Time of deposition—In this series of tests the percentage of electrolyte, the spacing of the plates and the generator setting were held constant, while the time of immersion of the plates was varied. The results are shown in Table 1. The total amount of deposit increased with increased time, but the dry slurry deposited per unit of time varied irregularly. The dryness of the deposit increased to a maximum at 1 minute, which therefore was considered to be the best time of immersion. The deposit per unit of power decreased with the length of time of immersion. This decrease is probably due to the depletion of the slip as the time is lengthened and also to the heating of the slurry, which started to boil after 1½ minutes. These conditions were not the same as those in the continuous flow machine.

Spacing electrodes—The minimum spacing of the plates is governed by the conductivity of the slurry, and the slurry will boil if too much current is carried between them. Tests were made in which electrolyte, time (1 minute) and generator setting were kept constant. The spacing was varied from 1.5 to 2.5 in. The results given in Table 2 indicate that the closer the plates, the heavier the deposit. The per cent of solids in the anode deposit has a maximum at the 2-in. spacing. The minimum power required per unit weight of dry slurry deposited and water removed was found at the 1.75-in. spacing. However, these results will show some variation with this type of equipment.

Temperature—Tests were made on slurry, without an electrolyte, to determine the effect of temperature on electrophoresis. The results shown in Table 3 are variable and indicate that the viscosity was increased, rather than decreased, with increased temperature; the dry slurry recovered was greater at 40 deg. C., but less at 51 deg. C., and the deposit contained less water at the higher temperatures. Water was evaporated from the cake on the heated anode when withdrawn from the slurry. However, if the anode temperature is too high, the cake will be loosened by steam action and will fall back into the tank. The data of Table 3 likewise indicate a lower rate of recovery and a wetter deposit when alkali was not used for dispersion.

TABLE 3

Effect of Temperature on Electrophoresis

Temperature, deg. C.	Viscosity,[1] grams	Amperes	Volts	Dry slurry recovered, pounds per hr. per sq. ft. anode surface submerged	Solids in anode deposit, per cent
25	25.5	1.9	111	26.2	66.0
35	28.5	2.3	114	25.7	66.7
40	28.0	2.6	113	30.6	67.3
51	26.0	3.3	112	28.1	68.0

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[1] No alkali used.

(*To be concluded*)

New National Portland Cement Co. Office Building Under Way

National Portland Cement Co. to Build Plant at Brodhead, Penna.; $2,700,000 Capital

Construction is under way on the plant office building of the new National Portland Cement Co. at Brodhead, Northampton Co., Penna. General offices are located in the Finance Building at Philadelphia and specifications for the plant buildings and machinery are to be issued shortly. The plant property comprises 204 acres in Lower Nazareth and Bethlehem Townships.

The National Portland Cement Co., organized by Fred B. Franks and capitalized at $2,700,000, will manufacture high-early-strength cement.

The organization of the company is as follows: President, Robert H. Anderson, Ambler; vice-president and general manager, Fred B. Franks, Sr., Allentown; treasurer, Louis Rafetto, Philadelphia; directors, Harold F. Ricker, Easton; Albert H. Ott, Bethlehem; L. Elwood Dize, Crisfield, Md.; Ira W. Richards, Easton; Arthur P. Houser, Emaus; J. M. Schoenly, Sr., Bethlehem, and Andrew P. Hachtman, chief engineer.

The Basing Point Formula and Cement Prices

Under date of March 26 the Federal Trade Commission submitted to Congress a report headed "The Basing-Point Formula and Cement Prices," accompanied by a 9-page letter of transmittal, which covers various phases of selling and distribution.

In discussing the basing-point system the letter of transmittal points out that the most significant aspect of the system is found in the divergent mill net prices which usually prevail under that system and obtain in a marked degree in the cement industry. Widely different mill net prices realized for any one mill at any one time upon substantial portions of the mill's sales are indicative of very imperfect price competition, because competition in price implies the frequent shading of a competitor's price, when costs permit, as an inducement of the seller to divert buyers from that competitor's product to his own. And the seller's costs presumably do permit it, if he is making to one group of buyers lower mill net prices than to some group or groups of buyers elsewhere in order to secure additional volume. Under active price competition the higher net prices tend to be shaded and sales to the lowest net price group discontinued, if necessary, until net prices generally are substantially equal.

Out of sales of 16,000,000 barrels made by 51 cement manufacturers to dealers in 21 cities, 1927 to 1929, only 35 per cent were made at the respective mill's maximum net prices prevailing at the time of sale. On 65 per cent of the sales there were deviations from the maximum mill nets ranging up to nearly $1.00 per barrel.

North American New York Plant Reopens in March

The North American Cement Corp. plant at Alsen, near Catskill, N. Y., reopened the middle of March with a working force of 143 men.

Self-Unloading Railway Tank Car Transports Bulk Cement

Capacity Is 70 Tons—Interior Mechanism and Unloading Equipment—Car Unloaded in Less Than Two Hours—Estimates of Savings Gained

THE General American Tank Car Corporation, in conjunction with Link-Belt Company, has developed a novel and unusual form of self-unloading tank car for the transportation of dry commodities in bulk. The car has been designated as the "Dry-Flo" car by General American.

Suitable for Many Commodities

Exhaustive tests indicate that this new car is suitable for shipping virtually all types of granular commodities. It has already handled such materials as cement and dolomite, as well as pebble lime, hydrated lime, soda ash, and other similar commodities.

In outward appearance the car is much like the ordinary tank car for transporting liquids, except that it has six openings in the top for loading instead of one. Like the tank car, it unloads through a single opening in the bottom, and does it automatically.

The single bottom outlet lends itself to simple conveying means to carry material from the car, and it saves time in unloading.

Interior Mechanism and Compartments

Inside, the car is divided into three compartments—two large compartments which carry the material and a small one at the center of the tank which houses the machinery by which it is unloaded. This mechanism is simple, foolproof and highly effective. It consists of power-driven drag chain conveyors, which are pulled along toward the center outlet by means of sprockets located in the center compartment. The conveyors are driven by a motor located in the dome, or by external power applied to a shaft provided for that purpose. The dome is equipped with hinged covers to allow access to the machinery for motor connection and clutch operation. All seams are securely riveted to provide absolutely water- and dust-proof construction. An ingenious gear speed reducer makes it possible to operate the conveyor chains very slowly. Provision is made for throwing out power on one end of the car, should it be desired to unload it at a lower rate of speed, and also for starting one end at a time, should the material be unduly packed or frozen.

Power is transmitted from a 1,200-rpm. ball-bearing electric motor to one right-hand and one left-hand speed reducer by a heavy-duty, double-roller chain. A plug receptacle for electrical connection is conveniently placed on the motor. A friction clutch is placed between the motor and speed reducers, to facilitate starting and stopping.

An unloading hopper is located at the bottom of the tank at the center of the car and extends downward between the center sills. The hopper opening is 11⅝ by 12 in. and is equipped with a gasketed sliding gate so arranged that it may be bolted and sealed in the closed position for shipment. This gate insures siftproof and water- and dust-tight construction.

To operate this unloading equipment it is necessary only to open a valve at the bottom of the car and connect up the motor to a source of electric power by means of a flexible cable. This done, the unloading proceeds entirely without assistance.

Unloaded in Less Than Two Hours

The car may generally be unloaded in less than 2 hours, varying slightly according to the commodity. This provides the discharge rate of about 400 cu. ft. per hr., using one chain, or 800 cu. ft. per hr., when using both chains. Discharge is arranged to empty the car completely.

The capacity of the two commodity compartments is 1,600 cu. ft., and the car will transport 70 tons of cement without utilizing the full cu. ft. capacity. Cement has been loaded, with 65 tons to the car, in 30 minutes, and unloaded in less than 2 hours. Cement company officials who inspected the unloading of a car which had returned

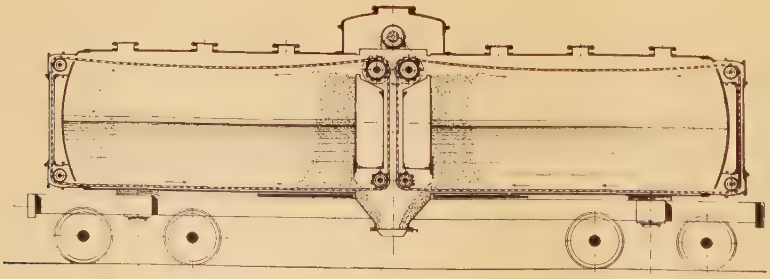

Figure 1. Longitudinal section, showing center bulkheads, driving unit and operation of drag chain conveyor

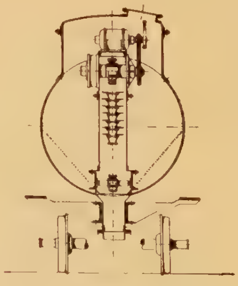

Figure 2. Cross section, showing slope sheets in tank, driving unit and drag chain

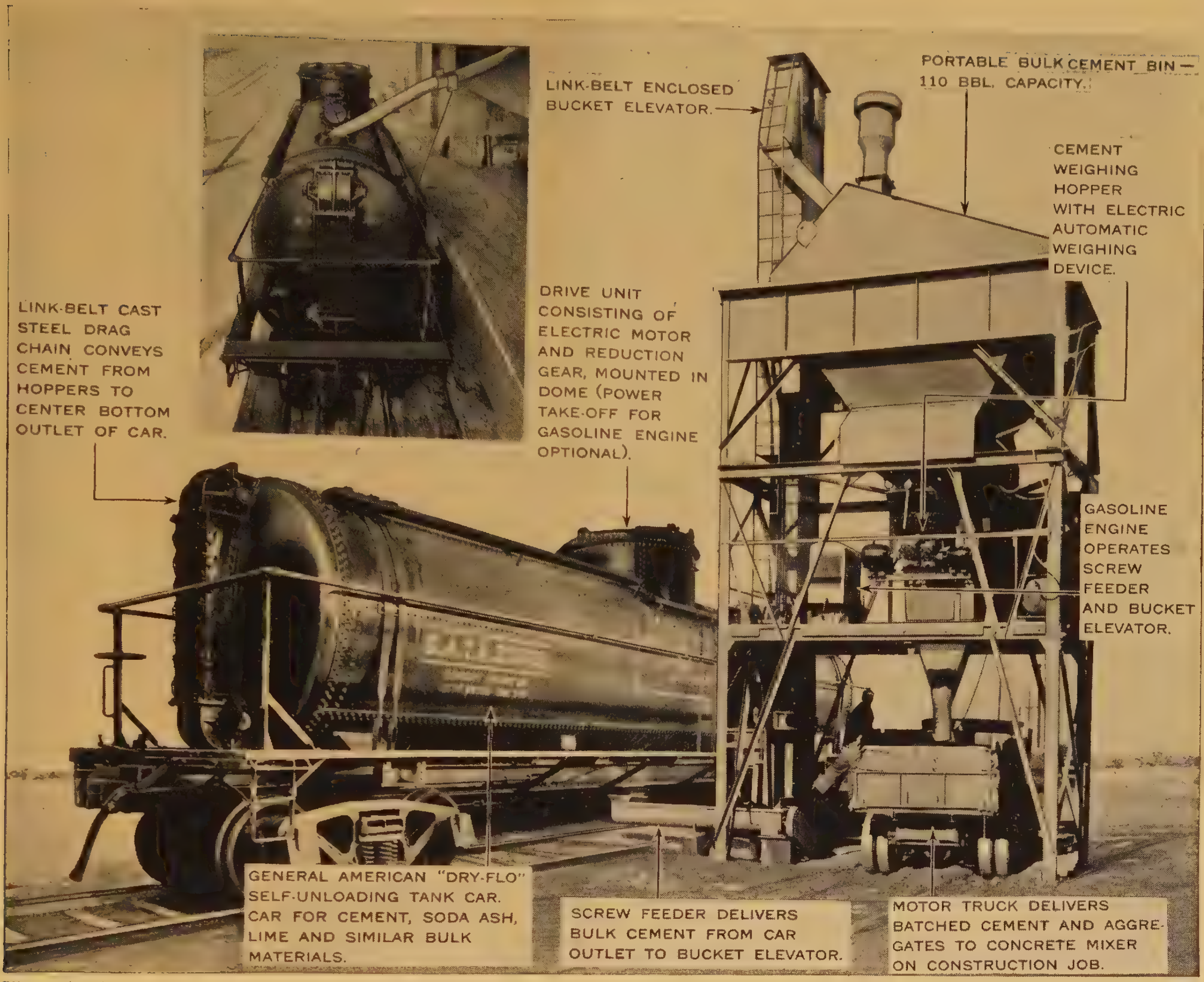
LINK-BELT ENCLOSED BUCKET ELEVATOR.
PORTABLE BULK CEMENT BIN—110 BBL. CAPACITY.
CEMENT WEIGHING HOPPER WITH ELECTRIC AUTOMATIC WEIGHING DEVICE.
LINK-BELT CAST STEEL DRAG CHAIN CONVEYS CEMENT FROM HOPPERS TO CENTER BOTTOM OUTLET OF CAR.
DRIVE UNIT CONSISTING OF ELECTRIC MOTOR AND REDUCTION GEAR, MOUNTED IN DOME (POWER TAKE-OFF FOR GASOLINE ENGINE OPTIONAL).
GASOLINE ENGINE OPERATES SCREW FEEDER AND BUCKET ELEVATOR.
GENERAL AMERICAN "DRY-FLO" SELF-UNLOADING TANK CAR. CAR FOR CEMENT, SODA ASH, LIME AND SIMILAR BULK MATERIALS.
SCREW FEEDER DELIVERS BULK CEMENT FROM CAR OUTLET TO BUCKET ELEVATOR.
MOTOR TRUCK DELIVERS BATCHED CEMENT AND AGGREGATES TO CONCRETE MIXER ON CONSTRUCTION JOB.

Illustration by courtesy of the Link-Belt Company.

Figure 3. Unloading operation shows screw feeder receiving cement from car and bucket elevator delivering to bin over portable batching plant

from a long test trip frankly admitted that they expected that "arching" would prevent the self-unloading of the cars. To their surprise, it did not, even after the jolting the cars received in the course of several hundred miles.

Estimates of Savings Gained

Where the car is substituted for sack shipment of cement, the saving of packages and labor has been estimated at $2 per ton, or $130 per trip per carload.

Savings are not confined to eliminating the cost of packaging and labor of loading and unloading, inasmuch as loss from dust is eliminated.

An estimate of savings, made for an oil company that uses hydrated lime instead of the 10 per cent less expensive and 28 per cent more effective quicklime because the latter is dangerous and disagreeable for men to handle, shows a potential saving of $3,000 per month or $1,000 per car. This is about a dozen times what it will cost to lease the car.

No expensive track hopper or system of unloading conveyors is required. A short screw feeder which may be swung or rolled under the car, above the rails, to receive the material discharged from the bottom outlet, is all that is needed. Figure 4 visualizes a typical unloading operation combining the car with the necessary conveying equipment and a bulk cement batching plant. The screw feeder from the car to the bucket elevator is a hinged or portable unit, quickly placed in position when the car is spotted at the plant. The car-unloading conveyors may be driven by the electric motor in the dome of the car, or from a gasoline engine located on the storage bin platform.

Universal Atlas and Alpha Plants Reopen

The Leeds, Ala., plant of the Universal Atlas Cement Co. reopened on April 4, after having been closed down for three months. One kiln was placed in operation and other kilns and the quarry will follow as demand improves.

The Phoenixville, Ala., plant and quarries of the Alpha company resumed operation the following week, when more than 50 men were called back to work.

Cement Association Meeting Late in Month

The spring meeting of the Portland Cement Association will be held at the Biltmore Hotel, New York City, May 31 to June 2.

EDITORIAL

The Railroads and Bulk Cement Shipments

AFTER many years of apparent indifference to the freight revenue possibilities in shipments of bulk cement by rail, some of the leading railroads now seem more favorably inclined to the idea.

It is true that for some years several cement companies have shipped bulk cement in specially designed company-owned railway cars. It is true also that considerable quantities of cement have been shipped in bulk in ordinary box cars, though it was by no means a convenient method—especially at the unloading end of the shipment.

Now, after losing considerable freight tonnage through the increasing use of water transportation for shipment of bulk cement, by some of the leading cement companies, the railroads are embarking on the development of the economical transportation of bulk cement and similar commodities in specially built cars owned by the railroads themselves. In consequence, this form of transportation becomes available to all cement manufacturing companies without a capital outlay on their part.

One of these new developments is a 70-ton tank car equipped with self-unloading mechanism, as described in an article in this issue.

Another is a hopper car that unloads by gravity, recently placed into service by at least three large railway companies. This railway-owned equipment consists of nothing more nor less than refitted coal cars, supplied with a tight roof, a bulkhead and special hopper discharge gates. The capacity is about 50 tons of bulk cement.

The two types of railway cars just mentioned should provide an economical means of transportation of bulk cement to large construction projects, to ready-mixed concrete plants, to concrete products plants, and to other large users having railway facilities available.

The Sintering Grate-Rotary Kiln Burning Process

IN last month's issue in an editorial headed "Will Our Burning Processes Be Changed?" reference was made to the new burning process, developed in Europe, which involves the use of a sintering grate in combination with a short rotary kiln.

That process, first described in our September (1931) issue, is now being brought to the attention of the American portland cement industry in complete detail in a series of articles by T. H. Arnold, starting in our April issue.

Private letters received by the Cement Mill Edition of "Concrete" from Spain and Luxemburg corroborate in every respect the results reported by Mr. Arnold.

In the Spanish plant—the Rezola plant at San Sebastian—a test run made late in 1931 resulted in an average output of 238.5 metric tons (1,398 bbl.) of well burned clinker in 24 hours, and a fuel consumption of 587,800 B.t.u. per barrel of clinker, or the equivalent of 47.0 lb. of 12,500-B.t.u. coal per barrel.

A similar test run in an installation in Luxemburg, at Esch-Alzette, resulted in an output up to 275 metric tons (1,612 bbl.) of well burned clinker in 24 hours, and a fuel consumption of 604,400 B.t.u. per barrel, equivalent to 48.3 lb. of 12,500-B.t.u. coal per barrel.

Power consumption for operating the kiln, the dryer and the coal mill was about the same, per barrel of clinker, as for the former rotary kiln installation.

Figures like these can not be ignored, regardless of the amount of capital which the cement industry may have invested in rotary kilns longer than 112 feet or thereabouts, which is about the maximum length required in the sintering grate-rotary kiln process.

The question, after all, is one of production costs. If, in this respect, the new process has a decided advantage over the old, the managements of mills that are in a position to finance the new installations will not hesitate to undertake the necessary rebuilding.

The Market in Minor Uses of Cement

WYOMING, with its great herds of sheep, is one of the leading sheep-raising states; but Ohio, with no great herds to boast of, raises an equal number of sheep. The secret lies in the fact that in Ohio almost every farm supports a small group of these animals.

Similarly, the minor uses of concrete consume but a small amount of cement on the individual contract, but the total utilized in that field runs into large figures.

The electric light and power companies provide an industrial parallel. The present reduced volume of current required by factories has been largely offset by the increased current needed for the operation of electric refrigerators and numerous other household articles.

The field of minor uses is well worth cultivating, in any industry.

High-Quality Cements No Monopoly of Large Production Units

Concluding Article Tells of Burning High-Strength Cement From Raw Materials Having Low Hydraulic Modulus—Double-Burning Process Effective

By E. LEDUC
Honorary Chief of Section of Materials of Construction of the National Conservatory of Arts and Trades, Paris

(*Concluded from April issue*)

THE article in the April issue described the predominating importance of fineness and uniformity of the raw mix, and the need for skill in burning. The choice of fuel was also discussed.

This concluding installment tells how the double-burning process produces high-strength cement from raw materials whose hydraulic coefficient is well below 2.00.

Underburned Clinker

Contrary to rotary kilns, which produce practically no underburned clinker, shaft kilns always produce more or less underburned material, and always some dust. On completion of the burning process, some underburned clinkers of a grey or yellowish color are usually found.

The grey and yellowish underburned clinker is formed at a temperature approximating that required for the dissociation of the carbonate of lime, as a result of which this type of clinker sometimes contains considerable quantities of carbonate of lime.

In these underburned clinkers one also finds larger quantities—we have found as much as 15 per cent in a grey sample—of free lime soluble in a sugar solution.

At the temperature of formation of these clinkers, the dicalcium silicate has already been formed, but there has not yet been any absorption of lime through the formation of the higher calcium compounds.

The sorting of the underburned clinker, a simple matter with ordinary shaft kilns, is more difficult with the automatic shaft kilns in which the discharging apparatus partly pulverizes the clinker and more especially the underburned clinker because of its low resistance to crushing.

Burning Hydraulic Lime a Second Time

With the hydraulic coefficient and the silica coefficient of the hydraulic lime manufactured in the plant at Xeuilley approaching closely those of portland cement, a technician is tempted to undertake the manufacture of portland cement by burning the hydraulic lime a second time, after correction, at a suitable temperature. It was this that Mr. Bocquet, manager of the plant, attempted to realize in a number of burning tests made during several months in a small vertical kiln. Later he continued the tests in a regular commercial kiln. The results obtained showed that the question merited further investigation, more especially so because by appropriate working of the quarry it was possible to bring out raw materials a little different in composition.

In view of the diverse products which we have attained in various cement plants, we did not hesitate, after making a study of the raw materials, to take the responsibility of guaranteeing the manufacture of a cement of superior quality and recommending the necessary expenditures for installations.

Examine Mixtures Having Low Hydraulic Modulus

Among our previous tests certain ones made for a special purpose gave results that were peculiarly interesting and a little at variance with present-day ideas. It was thus that 21 raw mixtures selected especially with the view of having hydraulic coefficients varying from 1.68 to 1.90, and silica coefficients from 1.56 to 1.82, when burned separately in a gas-fired kiln, confirmed our confidence in our ability to produce a superior cement, and corroborated certain observations set forth in preceding parts of this article.

At the temperature of 1,500 to 1,530 deg. C., none of the samples showed the slightest trace of dusting. All the clinkers obtained, without a single exception, were heavy, compact, durable, and of a characteristic dark greenish color. Ground the day after burning, the cement obtained indicated no trace of expansion.

High Strengths Attained

The time of set was entirely satisfactory. The strengths shown below indicated a cement of the very first quality, as we had guaranteed. The chemical composition of the clinker was as follows:

Silica	21.50 per cent
Alumina	9.70 per cent
Iron oxide	2.90 per cent
Lime	62.20 per cent
Hydraulic coefficient	1.85
Silica coefficient	1.70

The tensile strength of 1:3 mortar was as follows:

Age	Tensile strength. lb. per sq. in.
2 days	290
3 days	343
7 days	508
28 days	586

Translated from *Le Ciment* (Paris), November, 1931.

As is well known, slaked hydraulic limes are, taken collectively, much finer than pulverized and argillaceous limestone of the same chemical composition, because they contain a relatively high proportion of hydrate of lime in the molecular state. At the clinkering temperature this is peculiarly apt to enter into combination with the silicates and the aluminates already formed by the previous burning. A more perfect clinkerization therefore results.

Checking the Laboratory Results

It was interesting to check these laboratory results by a number of actual industrial tests. Furthermore, the manager of the Societe de Xeuilley, Mr. Fisson, kindly permitted us to repeat the tests with the rotary kiln in that plant, with the result that our experience was considerably widened. The results obtained with the rotary kiln have confirmed those obtained in the laboratory, as is shown in the following:

Hydraulic coefficient of raw materials, 1.58 to 1.98, with an average of 1.75.

Silica coefficient of raw materials, 1.55 to 1.96, with an average of 1.75.

The clinkers obtained indicated the same coefficients, with a smaller variation due to the influence of the ash content. Thus—

Hydraulic coefficient, 1.52 to 1.87, with an average of 1.75.

Silica coefficient, 1.50 to 1.76, with an average of 1.62.

Double-Burning Process Is Flexible

This experience, which was continued throughout a little more than a month, during which several thousand tons of clinker were produced, has shown that the double-burning process is an extremely flexible one, because of the homogeneity given to the mixture and also because of the combinations which have already been formed during the previous burning when siliceous or argillaceous limestones are employed. This process, as this test shows, permits the manufacture of high-strength cement with raw materials whose chemical composition is such that the hydraulic coefficient falls short of 2.00. It is possible that this fact may open a new way to certain plants.

Comparison With Theoretical Formulas

The application of the various formulas of Le Chatelier, Guttmann and Gille, Jaenecke, Kuhl, Meade, Michaelis, and Newberry, to the average composition of 11 samples of clinker selected at random from the discharge end of a rotary kiln, at intervals of several days between the taking of successive samples, shows that the determined percentage of lime is much less than the theoretically required percentages given by any one of those formulas.

The average chemical composition of the 11 samples was—

Silica	21.16 per cent
Alumina	9.13 per cent
Iron oxide	3.73 per cent
Lime	60.90 per cent
Magnesia	3.20 per cent
Sulphuric anhydride	1.90 per cent
Hydraulic coefficient	1.79
Silica coefficient	1.54

According to the formulas referred to, the calculated percentages of lime required to absorb the silica, the alumina and the iron oxide are—

	Per cent
Le Chatelier	69.83
Guttmann and Gille	75.61
Guttmann and Gille	76.93
Jaenecke	67.05
Kuhl	71.87
Meade	62.36
Michaelis	68.04
Newberry	69.28

If, from the percentage of 60.90, the quantity of lime required for combination with the sulphuric anhydride is deducted, there remains only 59.57 per cent of lime available for combination with the silica, the alumina and the iron oxide.

Facts Disagree With Formulas

As will be seen, the corrected quantity of lime (59.57 per cent) shown available by the analyses of the 11 samples of clinker is much below that required by any one of the eight formulas mentioned above. Meade's formula, which requires 90 per cent of the lime required by Newberry's formula, is the one to which the actual percentage approaches most closely.

If, instead of taking the formulas in which the silica is considered in the state of tricalcium silicate, one takes the silicates of lime and of magnesia at 2.5 CaO, and then leaves the alumina and the iron oxide in their tricalcium combinations, the calculation shows the necessary percentage of lime to be 63.80. In consequence, the actual quantity of lime (59.57 per cent) is below that indicated by the formula:

$$SiO_2.2.5\ CaO + Al_2O_3.CaO + Fe_2O_3.3\ CaO + SiO_2.2.5\ MgO$$

Nevertheless, in spite of this low lime content, the clinker produced by the rotary kiln at the Xeuilley plant during the entire period of this experiment was stable. There was not a trace of "dusting." After correction by the addition of a small amount of gypsum, the time of set was retarded and the strength was increased.

Evidently it is not sufficient to utilize modern equipment and to have excellent raw materials available. It is still necessary to control and check these materials, the finished cement, and the various phases of manufacture. Moreover, the technical control must be strict, to the point where checks on certain phases of manufacture are applied each hour.

A Small But Modern Cement Plant

A certain simply constructed cement plant is housed in a single building only 85 ft. wide and 246 ft. long. If the plant itself is simple, the installation is strictly modern. For instance, each piece of equipment of any consequence is direct-connected to its motor, through speed reducers. In other directions the protection of workmen from possible accidents and the effects of dust has been developed to the maximum. Furthermore, the clinker storage capacity and the grinding capacity are sufficient to permit prompt response to seasonal demands.

Make High-Strength Cement

Daily tests made in the plant laboratory show the following average tensile strengths of 1:3 mortar briquettes:

Age	Tensile strength, lb. per sq. in.
3 days	426 to 455
7 days	455 to 498
28 days	569 to 640

The initial set occurs in 2 hr. to 2 hr. 30 min., depending on whether the test is made in the air or under water, and the final set occurs in 6 to 8 hr.

The fineness of the finished cement varies from 4 to 6 per cent retained on the 178-mesh sieve (4,900 openings per sq. cm.).

No expansion occurs under the boiling test.

Samples of Xeuilley cement, recently tested in the laboratory of the National Conservatory of Arts and Trades, have shown the following results:

Retained on the 178-mesh sieve, 4.3 per cent.

Initial set in moist air, 2 hr. 15 min.

Final set in moist air, 7 hr.

Initial set under water, 2 hr. 15 min.

Final set under water, 8 hr.

Expansion under the boiling test, none.

Tensile strength of 1:3 mortar briquettes, 444 lb. per sq. in. in 3 days, 474 lb. in 7 days, and 616 lb. in 28 days.

In considering these results collectively, it can be said that the process employed in this plant constitutes a definite step in the progress of the cement industry.

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Properties of Tricalcium Aluminate and Dicalcium Ferrite

Unstable Character of Chemically Pure Compounds Believed Due to Large Increase in Volume Under Action of Contact Water

By D. L. SNADER

Research Fellow, Columbia University, and Professor of Civil Engineering, Stevens Institute of Technology

In last month's issue, pages 64 to 66, the author discussed the physical properties of chemically pure tricalcium silicate and dicalcium silicate. In this issue he describes the corresponding reactions and characteristics of chemically pure tricalcium aluminate and dicalcium ferrite.

The final installment in next month's issue will contain the conclusions of this investigator and R. J. Colony, concerning these four compounds.—The Editors.

THE first installment of Part II, published in the April Cement Mill Edition of CONCRETE, described the physical properties, characteristics and qualities of chemically pure samples of tricalcium silicate and dicalcium silicate. In the present installment similar characteristics of chemically pure tricalcium aluminate and dicalcium ferrite will be studied.

3. TRICALCIUM ALUMINATE

This compound requires at least 60.5 per cent of its own weight of gauging water to produce normal consistency. An average of 60.6 per cent was used in making the 28 test cylinders in six different lots. This compound requires slightly more water to make it plastic and workable than does tricalcium silicate.

A striking characteristic of this compound is the rise in temperature which begins almost immediately after the addition of the water to the dry material. This rise continues during mixing and for several minutes thereafter to a maximum temperature, then drops off gradually. For cylinders Nos. 133 to 137 temperature readings of the thoroughly mixed material were taken over a period of 20 minutes, the observations beginning immediately after thorough, vigorous mixing for four minutes. The thermometer was placed in the porcelain mixing dish and the carefully mixed material was quickly molded entirely around the thermometer bulb to a thickness of about one-quarter of an inch. It should be noted that because of the small quantity of mixed material, namely, 16.5 grams of the unhydrated material, considerable heat losses occurred from radiation, and a larger quantity of the mixed material would no doubt have given considerably higher temperatures. Nevertheless the development of heat dur-

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ing hydration and the rapid changes in temperature are qualitatively indicated in Figure 5. The following facts are observed:

1. A sudden and pronounced rise in temperature 10 minutes after the gauging water was added.
2. The highest temperature was reached 12 minutes after the water was added, or 6 minutes after completion of mixing.
3. A gradual falling off in temperature following the highest point reached at 12 minutes after the water was added.

Rapid Initial Set

Another equally striking characteristic is the rapidity with which tricalcium aluminate takes on an initial set, a so-called flash set, requiring extremely rapid placing of the mixed material in the molds. After 4 minutes of mixing the material is plastic and workable. On standing 3 to 4 more minutes it becomes dry-looking and stiff. A slight remixing without the use of additional mixing water is required to make it plastic again so that it can be placed in the molds. The remixed material has the same appearance and consistency as the original mix, namely, moist-looking, soft, and entirely workable.

Another interesting characteristic of calcium aluminate is its increase in volume which occurs without exception during the first two weeks when stored in the damp closet. This is distinct from the action of complete disintegration that occurs when aged cylinders of this compound are immersed in water as described later on. It is of value to note by way of comparison that cylinders of tricalcium silicate and of dicalcium silicate show without exception no change in volume during similar treatment in the damp closet, while cylinders of dicalcium ferrite show a much greater increase in volume than cylinders of tricalcium aluminate, and this volumetric change also continues for a long period of time.

Figure 5 gives for all of the test cylinders of tricalcium aluminate the per cent increase in volume at varying intervals of time for groups of cylinders having an age when tested in compression of from 7 days to 6 months. During the entire period all these cylinders were stored in the damp closet at about 70 deg. F. A constant volume appears to be reached at the age of about 10 days.

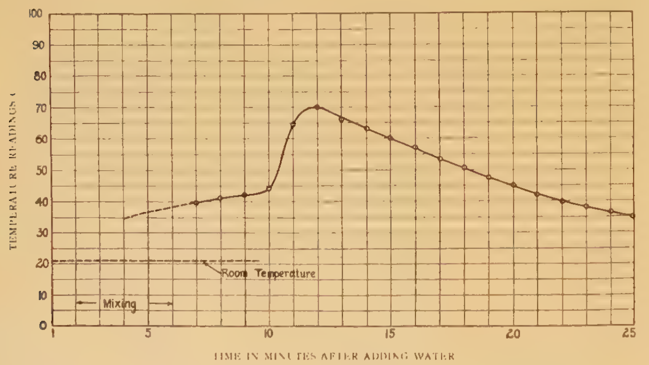


Figure 5. Temperatures resulting from hydration of tricalcium aluminate

Early Appearance of Cracks

Of further interest is the formation of a small number of cracks, both longitudinal and transverse, that developed without exception in all of the cylinders of tricalcium aluminate, almost immediately following molding and during storage in the damp closet. These cracks, observed under a magnification of 14X as early as 23 hours after molding, resembled shrinkage cracks; but they can not be explained as such, and their formation is coincident with and no doubt related to the volumetric change (increase) which takes place in the material during the first two weeks of hardening. A uniform expansion or swelling during hydration throughout the entire mass of the material could not account for the formation of these checks and cracks. They can only be accounted for by a greater volumetric change occurring in the central portion or core of the cylinder than in the exterior, which would tend to create the internal pressure necessary to bring about the cracking of the mass. This expansive action of the core is apparently accompanied by surface shrinkage resulting from loss of surface moisture, the net result being a surface shrinkage superimposed on an expanded central core.

4. DICALCIUM FERRITE

This compound requires at least 24.5 per cent of its own weight of gauging water to produce normal consistency. An average of 24.6 per cent was used in making the 26 test cylinders in six different lots. Dicalcium ferrite requires the smallest amount of gauging water of any of the four compounds.

No rise in temperature could be observed after the addition of the mixing water, as occurred in the case of tricalcium aluminate.

The material on completion of mixing is glossy and moist appearing; about 5 minutes later the surface of the mixed material becomes drier and dull-looking, but no remixing is required for completion of placing in the molds.

At all stages the mixed material is somewhat "pasty" and "gluey" and somewhat difficult to keep in the molds under methods of placing and tamping corresponding to the usual methods followed in placing portland cement mortars and concretes.

Dicalcium ferrite sets and hardens rapidly, but, without the flash set of tricalcium aluminate. It sets more quickly than tricalcium silicate or dicalcium silicate.

Two hours after placing the mixed material in the molds, considerable pressure is required to make an indentation with the fingernail. The cylinders at this time are harder than those of dicalcium silicate at the age of 2 to 3 days.

At the age of 3 hours the cylinders have set approximately as hard as those of dicalcium silicate at the age of 5 to 7 days.

After 4 hours the cylinders are harder than those of tricalcium aluminate at 5 hours, even though the initial set of tricalcium aluminate occurs much earlier.

At the age of one day cylinders of dicalcium ferrite were harder than tricalcium aluminate of the same age, and definitely harder than those of dicalcium silicate at the age of 7 to 8 days.

Cylinders of dicalcium ferrite may safely be removed from the molds at the age of 22 hours, about 2 hours earlier than those of tricalcium aluminate.

A very interesting and striking characteristic of dicalcium ferrite is the enormous volumetric increase which occurs without exception during storage or curing in the damp closet. This change in volume was continuous over the entire period of observation (6 months), but about two-thirds to three-fourths occurred during the first month.

Figure 6 gives for all of the cylinders of dicalcium ferrite the per cent increase in volume up to the time when they were tested in compression. All cylinders were removed from the molds 22 hours after placing, and observations on changes in diameter and length were begun at the time of removal from the molds. The cylinders were stored in the damp closet at about 70 deg. F. during the entire curing period.

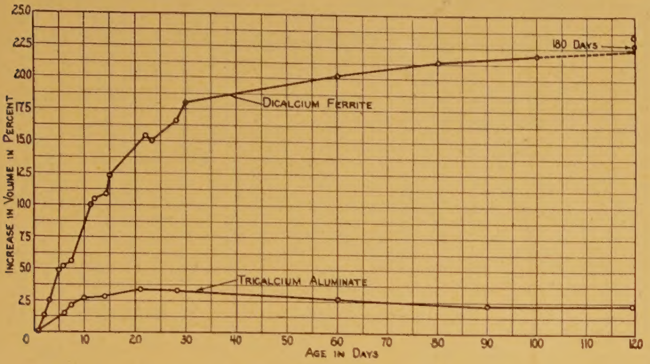


Figure 6. Percentage increase in volume with age, developed by dicalcium ferrite and tricalcium aluminate when stored in damp closet

Checks and Cracks Develop Quickly

Of equal interest is the formation and growth of numerous checks and cracks that develop without exception in test cylinders of dicalcium ferrite, almost immediately following molding during storage in the damp closet. Their formation and growth in size are coincident with and no doubt related to the volumetric change which takes place in the material when it hardens. A uniform expansion or swelling during hydration throughout the entire mass of the material could not account for the formation of these checks and cracks. They can only be accounted for by greater volumetric changes occurring in the central portion or core of the cylinder, which would tend to set up the internal pressure necessary to bring about the cracking of the mass. This action, combined with surface shrinkage brought about by loss of surface moisture, resulting in superimposed surface shrinkage, appears to be the explanation of the subsequent and rapid widening of these cracks when once formed.

The observed formation and growth of the checks and cracks in the molded ½ by 1-in. cylinders of dicalcium ferrite was as follows:

At the age of 22 hours, and just before the cylinders were removed from the molds, minute small checks and cracks had developed in the top uncovered face of all cylinders. These cracks were observed under a magnification of 14X and some were already visible to the unaided eye.

At the age of 24 hours these cracks were more pronounced.

At the age of 4 days checks and cracks had developed on all surfaces to the extent that small pieces had loosened from the ends of the cylinders.

At 5 days' age, the checks and cracks were intertwining in all directions and existed on all surfaces.

Three cylinders purposely left in the molds for 7 days became so tightly wedged in the split steel molds through expansion that it was impossible to remove them whole.

The checks and cracks continued to grow in depth and expanded in width with age. At the age of 14 days they penetrated very deeply into the cylinder, extending probably to its center, and small pieces became loosened and tended to break away even when handled with great care.

Observations made at later periods up to 6 months showed continued growth in the size and extension of the intertwining checks and cracks, and especially as the age increased the cylinders became so badly cracked that very careful handling was necessary; and even then small pieces became dislodged and fell away.

At the end of 6 months, the cracks had grown to such size that complete disintegration was liable to occur at any time, even under ideal conditions.

That partial disintegration existed throughout the entire mass was evident from the uniformity of occurrence of the cracks over all cylindrical and end surfaces; and further, when subjected to compression, the cylinder broke up into many small pieces, having some approach to uniformity of size.

Similarity to Disintegrated Concrete

The common checking, cracking and breaking up of concrete that is in process of disintegration greatly resemble the disintegration of dicalcium ferrite. Most of the concrete structures exposed to the elements have developed more or less deterioration of this nature, a typical example of which is shown in Figure 7.

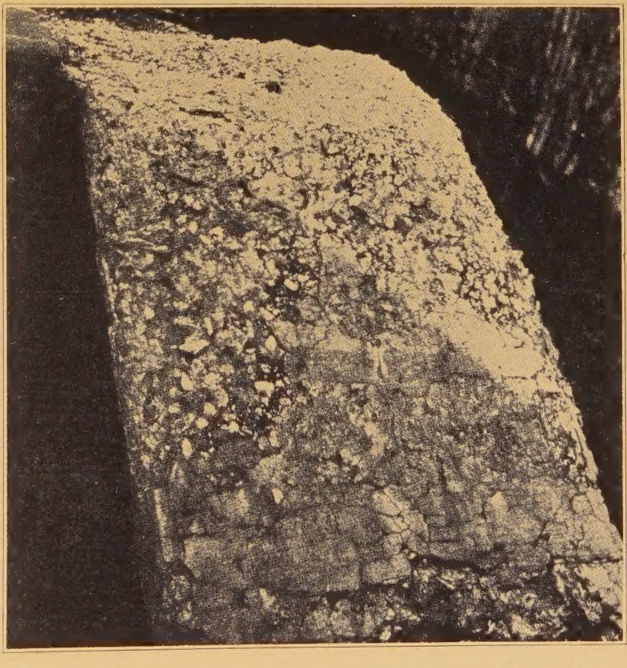


Figure 7. Surface disintegration of concrete exposed to weather resembles disintegration of dicalcium ferrite

Figure 7 is made from a photograph selected from a series of more than 125 photographs taken by the writer, of concrete structures in a more or less advanced state of disintegration. Most of these structures exhibit a surface condition very similar in appearance to that of the molded cylinders of dicalcium ferrite.

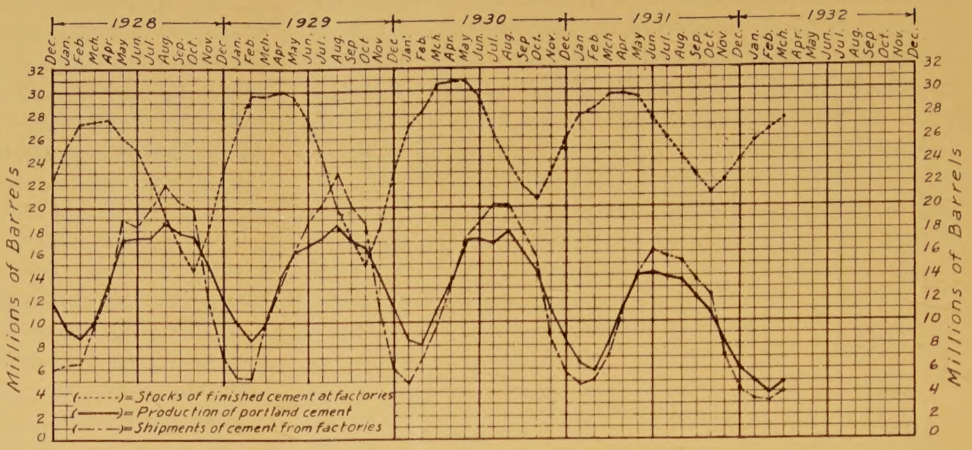
(To be concluded)

Cement Statistics for March

Production and Shipments Gain Some Seasonal Ground

Relation of Production to Capacity

	The Month, Per Cent	The Twelve Months, Per Cent
March, 1932	21.3	43.8
March, 1931	**36.9**	**58.6**
February, 1932	18.7	45.2
January, 1932	22.0	45.9
December, 1931	26.4	46.5



	1931	1932	Increase or Decrease, %
Production, March	**8,245,000**	4,847,000	—41.2
Shipments, March	**7,192,000**	3,973,000	—44.8
Stocks at end of month	**29,676,000**	27,530,000	—7.2

	1931	1932	Increase or Decrease, %
Total production for yr.	**20,760,000**	13,844,000	—49.9
Total shipments for yr.	**16,958,000**	10,484,000	—61.7
No. of plants reporting	165	165	0

Production, Shipments, and Stocks of Finished Portland Cement, by Districts, in March, 1931 and 1932, and Stocks in February, 1932 (In Barrels)

District	Production—March 1931	Production—March 1932	Shipments—March 1931	Shipments—March 1932	Stocks at end of month 1931	Stocks at end of month 1932	Stocks at end of February, 1932*
Eastern Pa., N. J. and Md.	**2,293,000**	1,509,000	**1,724,000**	978,000	**6,622,000**	6,237,000	5,706,000
New York and Maine	437,000	**570,000**	**381,000**	237,000	**2,013,000**	1,909,000	1,575,000
Ohio, Western Pa. and W. Va.	**444,000**	241,000	**595,000**	269,000	**3,565,000**	3,377,000	3,405,000
Michigan	**72,000**	53,000	**286,000**	128,000	**2,600,000**	2,017,000	2,093,000
Wis., Ill., Ind. and Ky.	**797,000**	688,000	**526,000**	256,000	**4,237,000**	3,817,000	3,386,000
Va., Tenn., Ala., Ga., Fla. and La.	**942,000**	300,000	**1,061,000**	448,000	**1,714,000**	1,601,000	1,749,000
Eastern Mo., Ia., Minn. and S. Dak.	**869,000**	325,000	**494,000**	243,000	**3,833,000**	3,808,000	3,726,000
W. Mo., Nebr., Kans., Okla. and Ark.	**638,000**	251,000	**520,000**	288,000	**2,196,000**	1,905,000	1,942,000
Texas	**489,000**	304,000	**456,000**	380,000	**773,000**	771,000	847,000
Colo., Mont., Utah, Wyo. and Idaho	**192,000**	39,000	**126,000**	64,000	**552,000**	431,000	456,000
California	**830,000**	521,000	**770,000**	547,000	998,000	**1,098,000**	1,124,000
Oregon and Washington	**242,000**	46,000	**253,000**	135,000	**573,000**	559,000	648,000
	8,245,000	4,847,000	**7,192,000**	3,973,000	**29,676,000**	27,530,000	26,657,000

Production, Shipments, and Stocks of Finished Portland Cement, by Months, in 1931 and 1932 (In Barrels)

Month	—Production— 1931	—Production— 1932	—Shipments— 1931	—Shipments— 1932	Stocks at end of month 1931	Stocks at end of month 1932
January	**6,695,000**	5,026,000	**4,692,000**	3,393,000	**27,759,000**	25,778,000
February	**5,920,000**	3,971,000	**5,074,000**	3,118,000	**28,612,000**	*26,657,000
March	**8,245,000**	4,847,000	**7,192,000**	3,973,000	**29,676,000**	27,530,000
April	11,245,000		11,184,000		29,715,000	
May	14,010,000		14,200,000		29,554,000	
June	14,118,000		16,077,000		27,602,000	
July	13,899,000		15,545,000		25,934,000	
August	13,549,000		15,172,000		24,313,000	
September	12,092,000		13,671,000		22,736,000	
October	10,762,000		12,360,000		21,128,000	
November	8,161,000		7,156,000		22,219,000	
December	5,974,000		4,142,000		*24,098,000	
	124,570,000		126,465,000			

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*Revised.

Blacker type indicates larger of two figures.

MEN and MILLS

[News of and for Cement Mill Men]

A clearing-house page for all kinds of local cement mill news—to promote the comradeship and mutuality of interest that exists among those who make portland cement.

Readers in all mills, even though not regular contributors, are invited to send in news notes about personal and plant activities that may be of interest or value to the men in other mills.

Lone Star Pennsylvania Appoints Kerby as Sales Manager

The Lone Star Cement Co., Pennsylvania, announces the appointment on April 1 of H. E. Kerby as sales manager.

He succeeds R. J. Mahon, who has been transferred to the New York office of the International Cement Corporation.

Death Claims Frank Patterson, Fredonia Co. Owner

Frank H. Patterson, owner of the former Fredonia Portland Cement Co., passed away at the Mayo clinic at Rochester, Minn., on April 2. Mr. Patterson had been in ill health during the winter and went to the Mayo clinic in December.

Mr. Patterson continued his keen interest in the cement industry after the sale of his plant to the Consolidated Cement Corp. in 1926.

In August, 1923, Mr. Patterson projected a plan of twelve months' employment for his employees, in which he had erected various types of small concrete structures. Among these was a tourist camp house donated to the city of Fredonia.

G. A. Saeger Leaves Missouri Portland Cement

Geoff A. Saeger, chemical engineer for the Missouri Portland Cement Co. for a number of years, severed his connections with that company on April 1.

Mr. Saeger is a recognized authority on the chemistry of cement and cement manufacturing processes, and has been active in these phases of the work of technical organizations such as the American Society for Testing Materials and the American Concrete Institute.

J. R. Maxwell, Former Atlas Office Head, Passes Away

John Rogers Maxwell, 57, formerly head of the Philadelphia office of the Atlas Portland Cement Co., died of heart disease at his home in Villanova, Pa.

Mr. Maxwell retired in 1917 as head of the office of the Atlas company, of which he was a director and his father the founder.

Born in Brooklyn, he was educated at Brooklyn Polytechnic Institute and Amherst College, graduating from the latter in 1897.

Mr. Maxwell occupied his time chiefly with traveling and golf. He was also interested, in his earlier career, in boat racing, gaining distinction with both his own and his father's boats on Long Island Sound.

He was a member of the New York Yacht Club, Corinthian Yacht Club, the Racquet and Tennis Club of New York, Racquet Club of Philadelphia, Pine Valley Golf Club, Merion Cricket Club, Gulph Mills Golf Club and Nassau Country Club.

R. J. Peterson, Manitowoc Power Plant Operator, Passes Away

Robert J. Peterson, power plant operator at the Manitowoc Portland Cement Co. plant, Manitowoc, Wis., passed away at his home there after an illness of about eight weeks.

Mr. Peterson was born in Manitowoc in 1886. For a number of years he had made his home in Appleton, Wis. He had been affiliated with the plant for the last ten years.

Former Atlas Sales Manager Joins Life Insurance Co.

Louis J. (Lou) Williams, district sales manager at Birmingham, Ala., for the former Atlas Portland Cement Co., has been appointed special representative of the Protective Life Insurance Co. there.

He joined the staff of the Atlas company in 1921 and in 1926 was transferred to Kansas City as manager. He returned to Birmingham in 1929 as district sales manager.

Chas. Boettcher Passes 80-Year Mark

Charles Boettcher, president of the Ideal Cement Co., the founder and one of the largest owners of the Great Western Sugar Co., and financially interested in many other Colorado industries, celebrated his eightieth birthday anniversary April 8.

Mr. Boettcher arrived in America from Germany at the age of 17. His first business activity was the selling of hardware.

L. J. Wheeler Succeeds Bonnell at Dallas Plant

Louis J. Wheeler has been transferred to the Lone Star plant at Dallas, Texas, as superintendent, from the Bonner Springs, Kansas, plant. He succeeds J. E. Bonnell.

Mr. Wheeler started his career in the cement business upon his return from the army in 1919. His first position was at Dallas as draftsman in the engineering department of the company. In 1921 he was sent to the Cuban plant in the same capacity, and in 1920 promoted to the position of assistant superintendent of that plant. Three years later he left for the general offices in New York City, where he held the position of mechanical engineer for two years.

Following the acquirement of the Bonner Springs plant by International in 1925 and its subsequent rebuilding, Wheeler was transferred there under the title of assistant to the superintendent, and the same year was appointed superintendent.

Grinding Balls Make Good "Mibbs" in Manitowoc

A cache of almost 200 lb. of steel grinding balls was uncovered by a Manitowoc, Wis., detective following a complaint by the Manitowoc Portland Cement Co., reporting their disappearance.

It developed that a boy had found the box of balls outside of the plant and had taken a number of the smaller sizes and used them in playing "mibbs." A procession of other lads down to the plant followed and the investigator is not certain he has recovered all of the balls.

Southwestern Host to Groups of Students

Two large groups of students were the guests of the Southwestern Portland Cement Co. at Victorville, Calif., on March 18 to 20.

An engineering class of from 40 to 50 students of the University of Southern California arrived on the afternoon of the 18th, made a study of the plant and departed the following day. On the same day 40 to 50 students of the Herbert Hoover high school of Glendale arrived, spent the night, and departed on Sunday. The latter class has been making a tour of the plant yearly.

Electric Eye and Brain Weigh, Record Moving Material

Beam of Light Measures Steady Flow of Material on Conveyor Belt—Main Principle of Light-Control Application

Accurately weighing the steady flow of material passing by on a conveyor belt; keeping careful count of the tons that have been handled, and, finally, recording on a time chart the belt loadings throughout the twenty-four hours of the day—such is the latest job undertaken by electric eye and ingenious electric brain.

The main principle of this light-control application is as follows: To obtain the weight of a continuous flow of material, it is necessary to combine the size of the stream with the speed at which it moves. The speed may be constant, but the size of the stream may range from zero pounds per foot to the full capacity of the conveyor.

At the point where the continuous stream of material is to be weighed, a short section of belt is installed, mounted in such manner that its varying weight is communicated to the weight checking equipment placed directly above. With the varying weight of the load on the conveyor belt, the beam of the weight checking mechanism is actuated. The scale load at one end causes the fulcrumed beam to swing over the scale of the load indicator at the far or free end.

Close to the free end of the swinging beam is mounted a cross arm carrying a Burgess Radiovisor bridge or simplified form of light-sensitive cell, and a light source lamp. These members are so mounted that one is outside while the other is inside a revolving light-chopper cylinder which is driven in step with the speed of the belt.

The telepoise, as the ingenious continuous weighing and recording mechanism is termed by its designer, E. J. White of the staff of John Chatillon & Sons, pioneer builders of scales, is finding many applications in mines, power plants, warehouses, factories and other establishments where bulky materials must be weighed while in motion.

In balancing the scale, a test weight is used representing half load when hung on the beam. A switch serves to cut out the integrator and throw in a small lamp which flashes at each impulse. A change gear is provided, which slows up the revolutions of the chopper cylinder so that the flashes may be counted. With no load on the moving belt, there should be 16 flashes for each complete cycle if the machine is properly balanced.

The bridge, light source and chopper cylinder serve to produce the necessary electrical impulses which are amplified by a two-stage amplifier designed and built by the engineering staff of the Burgess Battery Company of New York City.

Selling Basis of Leather Belting Changed from Weight to Thickness

The American Leather Belting Association has decided that for the greater protection of the consumers of leather belting, it should establish and sell this commodity by specifications of thickness instead of weight, thereby discarding the old weight terminology of "ounces per square foot" which may be varied by the mere addition of weighting materials to the leather. This decision was reached after the association had canvassed all manufacturers of belting throughout the country, with the result that 81 replies were received, all voting for the change.

This move simplifies and makes comparatively easy the checking of each piece of belting.

Mill Equipment

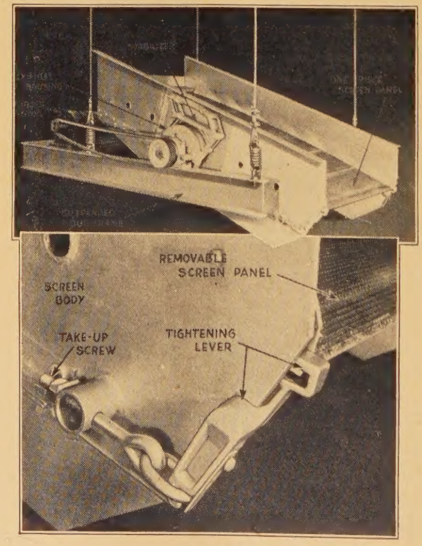
New Features for Vibrator Screens Announced

A unique, quick-change screen panel is said to be one of the outstanding features of the new vibrator screen announced by Stephens-Adamson Mfg. Co., Aurora, Illinois. The screen is of the positive vibration type in which the rigid screen body, with one or more decks, is given a vibration of fixed amplitude by the rapid "throw" of a heavy eccentric shaft.

The vibrator mechanism is a self-contained, factory adjusted unit. It consists of an eccentric shaft, adjustable balance wheels, heavy SKF, double row ball and roller bearings, labyrinth grease seals and a tubular cast steel housing.

Other features of the new screen are: 1, quick-change, reversible screen panels; 2, stretching levers for screen cloth; 3, stabilizer mounting; 4, added protection for bearings; 5, cushion springs for suspension cables.

The new quick-change panel is a full size piece of screen cloth with a stiff structural steel angle brazed to each end. The panel is placed by sliding into position until the ends of upper cross angle drop into sockets in side frames. Stretching levers are slipped on the ends of lower angle and tightened as shown in the illustration.



Field Activities

Torrence Elected Link-Belt President

On March 22, at the fifty-eighth annual meeting of stockholders, *George Paull Torrence*, vice-president in charge of the company's Indianapolis operations, was elected president of *Link-Belt Co.*, with headquarters at the executive offices at Chicago.

Mr. Torrence entered the employ of the company in 1911 as a sales engineer at Indianapolis. In 1915 he was placed in charge of merchandise and chain sales in the company's western division, with headquarters in Chicago. In 1920 he returned to Indianapolis in the capacity of sales manager of the Ewart works; in 1925 he was made general manager of both the Dodge and Ewart plants; and in 1928, vice-president of the company, with headquarters in Indianapolis. His next step was into the presidency.